

Supplemental Rumen-Protected Choline and Methionine for Lactating Dairy Cows

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Abstract

The purpose of the experiment was to determine the effects of supplemental rumen-protected choline [Reashure[®] (REA)] and rumen protected methionine (Smartamine M[™]) on the metabolism and performance of lactating dairy cows. Analyses were performed to measure both milk and plasma choline and nonesterified fatty acids (NEFA) and glucose in plasma. Milk samples were analyzed for fat, protein and urea nitrogen (MUN). The 56 lactating dairy cows were fed one of 4 diets at parturition: 1) control (duodenal flow of lysine:methionine (lys:met) 3.8; NRC, 2001), 2) 0.26% rumen protected choline (RPC) (REA fed at 60 g/d to provide 15 g/d of choline; lys:met 3.8; REA-L), 3) 0.52% RPC (REA fed at 120 g/d to provide 30 g/d of choline; lys:met 3.8; REA-H), or 4) 0.096% rumen protected methionine (Smartamine M[™]; lys:met 3.0; MET). The diets were fed as a total mixed ration (TMR) for 13 weeks and were composed of 52% forage (76% corn silage and 24% alfalfa hay), 9% whole linted cottonseed, and 39% concentrates. The diets were 16.8% crude protein, 39.2% NDF, and 20% forage NDF. Thirty-one Holstein and 17 Jersey (48 total) cows completed the trial. Upon analysis, dry matter intake (DMI) (20.6 kg/day), milk yield (36.5 kg/day), milk fat (4.35%), and milk protein (3.14%) were found to be the same among all 4 diets. The MUN was the highest for REA-H (19.1 mg/dl) and intermediate for MET (18.1 mg/dl). Milk choline showed a significant increase for MET, but plasma choline and non-esterified fatty acids (NEFA) were not different for the diets. Plasma glucose was higher for both the control and MET diets than for either REA diet. Plasma methionine was significantly higher for the MET diet than for other diets. Milk choline was a better indicator for choline status than was plasma choline, and cows on the MET diet showed a higher milk choline concentration than did those on the RPC diet.

Introduction

Evidence suggests that the supply of choline in dairy cows that have just calved may be inadequate, even though choline can be synthesized by the animal (Donkin, 2002; Piepenbrink and Overton, 2003). Choline is essential as a component of phospholipids which are important for proper membrane function and in the structure of lipoproteins that transport lipids in the blood. This transport of lipids in the blood may be an important factor in preventing fatty liver disease and ketosis in periparturient dairy cows. Providing supplemental choline may improve the transport of lipids, thus reducing the risk for ketosis, and may also increase the yields of milk and milk fat. Because most dietary choline is degraded in the rumen (Sharma and Erdman, 1989), not much is available for absorption; therefore, choline must be rumen protected when fed.

Choline has previously been measured in blood (Takayama et al., 1977) and milk (Deuchler et al., 1996), and it appears that milk choline concentration may be the better indicator of choline absorption (Deuchler et al., 1996). To date, the concentrations in blood and milk have not been compared in the same experiment to determine their appropriateness in being used to indicate choline absorption.

Methionine also functions in forming phosphatidylcholine, an important factor in lipoprotein complexes (Sharma and Erdman, 1988). Methionine is one of the primary limiting amino acids in lactating dairy cows and is a component of apolipoprotein in lipoprotein complexes for the transport of lipids in blood. Unless methionine is rumen protected, it also will be degraded in the rumen and be unavailable for absorption. We are unaware of research focusing on the comparison of the effects of rumen protected choline and methionine on choline status and metabolism of the periparturient dairy cow.

Objectives

The objectives of this research were to determine animal responses to supplemental rumen-protected choline and methionine and determine if plasma and milk choline concentrations are good indicators of choline absorption.

Materials and Methods

1. Experimental Design and Diets

Fifty-six Holstein and Jersey cows were fed the following diets beginning at parturition: 1) control (duodenal flow of lysine:methionine (lys:met) 3.8; NRC, 2001), 2) 0.26% RPC (Reashure (REA), Balchem Corp., New Hampton, NY; targeted at 60 g/d to provide 15 g/d of choline; lys:met 3.8; REA-L), 3) 0.52% RPC (REA; 120 g/d to provide 30 g/d of choline; lys:met 3.8; REA-H), or 4) 0.096% rumen-protected methionine (Smartamine MTM, Adisseo, Antony Cedex, France; lys:met 3.0; MET). The diets were fed as a total mixed ration (TMR) for 13 weeks and were composed of 52% forage (76% corn silage and 24% alfalfa hay), 9% whole linted cottonseed, and 39% concentrates. The diets contained 16.8% crude protein, 39.2% neutral detergent fiber (NDF), and 20% forage NDF. Concentrations of Reasure were determined by a previous trial by using the rate at which the product was broken down in the rumen. Thirty-one Holstein and 17 Jersey cows (48 total) completed the trial.

2. Sampling

Blood samples were collected from the tail vein of each cow on days 15, 30, 60, and 90 of milking. Corresponding milk samples were taken and stored at -4°F. Milk samples were also taken for 2 days each week, allowing for 4 samples (2 AM milkings and 2 PM milkings) from each cow during each week of the trial to be analyzed for fat, protein, and urea nitrogen. Dry matter intake (DMI) and milk yield were recorded daily, body weights were recorded weekly, samples of TMR and forage were taken weekly, and body condition scores were recorded at the start and end of the trial as well as every 4 weeks.

3. Sample Analyses

Blood samples were centrifuged and plasma was stored at -4°F for later analysis. Milk samples were treated with a perchloric acid solution and centrifuged. The supernatant was collected and stored at -4°F for choline analysis. Non-esterified fatty acid (NEFA) analysis on the plasma followed the protocol by Johnson and Peters (1993) and samples were read using a spectrophotometer. Plasma glucose was determined using a protocol including glucose oxidase, peroxidase, phenol, and 4-aminoantipyrine, and the color reaction was read on a spectrophotometer. For plasma and milk choline, a chromogenic reagent containing various enzymes to free the choline molecules was added to each sample before they were read in the spectrophotometer (modified from Takayama et al., 1977). Milk samples were sent to DHI Cooperative, Inc. (Columbus, OH) on a weekly basis and analyzed for milk urea nitrogen (MUN) using a Skalar SAN Plus segmented flow analyzer and for milk fat and milk protein using infrared spectroscopy. Plasma methionine concentrations were analyzed by the Experiment Station Chemical Labs (University of Missouri, Columbia).

Results and Conclusions

The DMI (20.6 kg/day), milk yield (36.5 kg/day), milk fat (4.35%), and milk protein (3.14%) were found to be similar among all 4 treatments (**Table 1**). The MUN concentrations were highest for REA-H (19.1 mg/dl) and intermediate for MET (18.1 mg/dl).

Plasma glucose was higher for both the control and MET diets than for either REA diet (**Figure 1**). Plasma NEFA concentrations were similar among treatments. Plasma methionine concentrations were highest for MET (4.67 ug/ml) and similar for all other treatments.

Milk choline was significantly higher for MET, but plasma choline was similar among the diets (**Figure 2**).

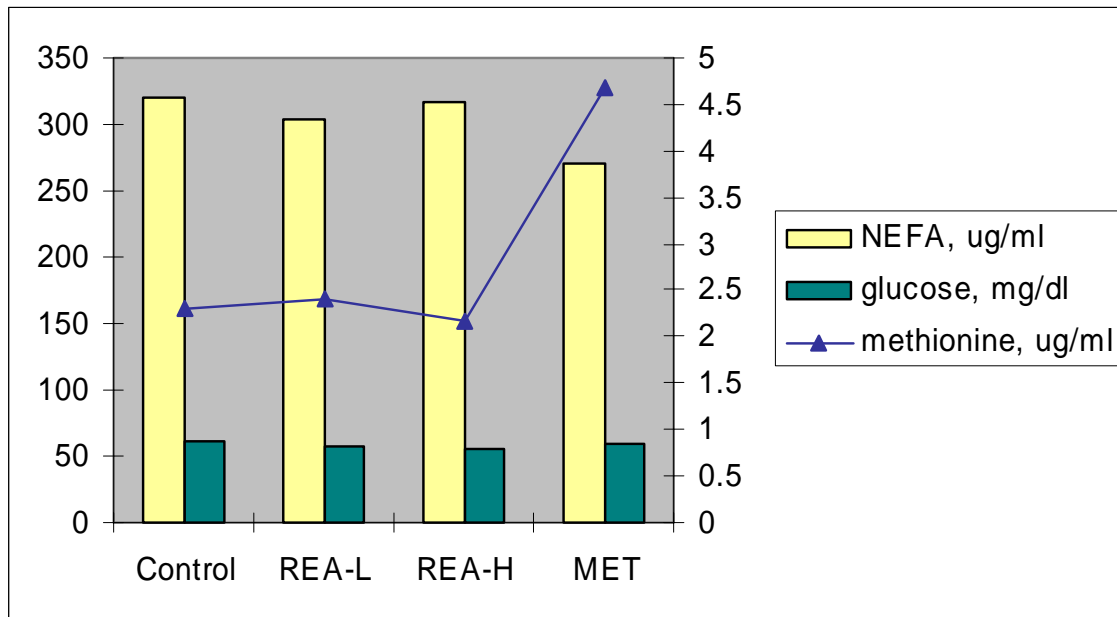
Milk choline was a better indicator for choline status than was plasma choline, and cows on the MET diet showed a higher milk choline concentration than did those on the RPC diets. Thus, feeding MET to the periparturient dairy cow may be more beneficial for reducing risks of metabolic diseases and improving animal performance related to choline status.

Table 1. Animal performance and milk composition by treatment.¹

Variable	Control	REA-L	REA-H	MET	Standard Error
DMI, kg/d	19.5	20.4	20.1	22.2	1.4
BW, kg	527 ^a	551 ^{ac}	506 ^{ab}	560 ^c	26
DMI, % of BW	3.69	3.74	3.97	4.04	0.16
Milk, kg/d	34.8	34.9	39.4	36.9	3
Milk fat, %	4.46	4.31	4.24	4.38	0.12
Milk protein, %	3.15	3.15	3.06	3.21	0.09
MUN, mg/dl	17 ^a	17.4 ^a	19.1 ^b	18.1 ^c	0.7
BCS	2.85	2.98	2.67	2.91	0.12

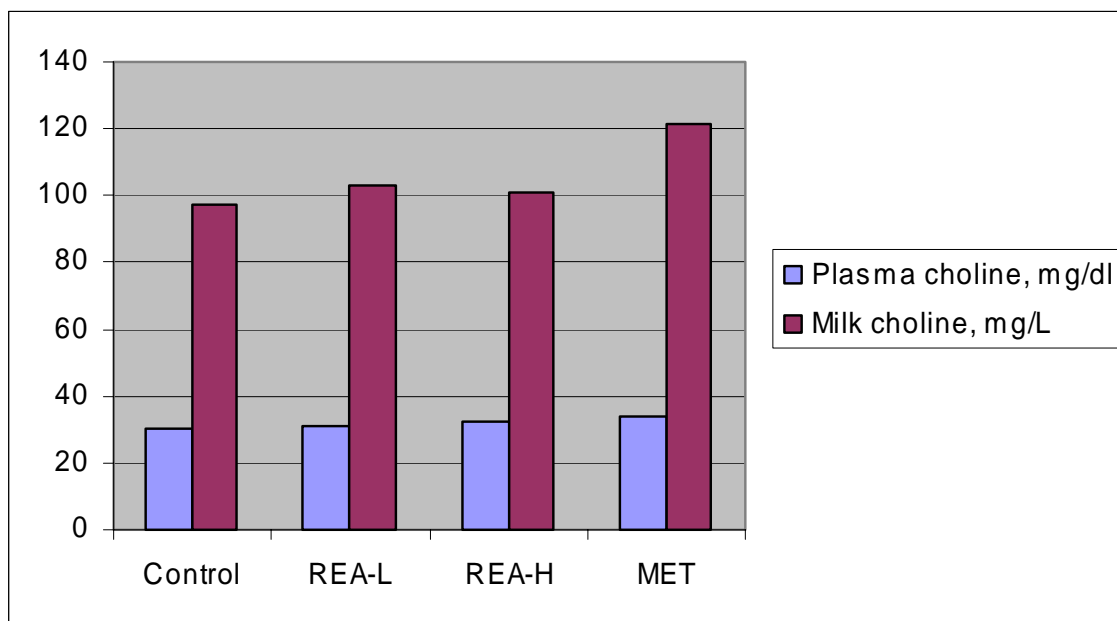
^{abc}Means in the same row with different superscripts differ ($P < 0.05$)

¹REA-L = 15 g/day choline, REA-H = 30 g/day choline, MET = methionine, DMI = dry matter intake, BW = body weight, MUN = milk urea nitrogen, and BCS = body condition score.

Figure 1. Plasma non-esterified fatty acids (NEFA), glucose, and methionine concentrations by treatment.¹

¹Y-axis on left pertains to NEFA and glucose data and the right axis to plasma methionine concentrations.

Figure 2. Plasma and and milk choline concentrations by treatment.



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